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Thank you Mr. Chairman, Distinguished Representatives, and guests, my name is Jon Warzel and I am the Vice President of Business Development and Government Programs for Syntroleum Corporation. Syntroleum is a publicly held company based in Tulsa, Oklahoma focused on the application of its proprietary Fischer-Tropsch ("FT") technology for the conversion of natural gas and coal to liquid hydrocarbon transportation fuels and other specialty products, such as lubricating oils. Syntroleum has over 20 years of comprehensive technology development, with a combined 127 US and foreign patent applications pending and issued. Currently, Syntroleum has the only fully integrated FT plant capable of producing a finished transportation fuel in North America. My objective today is to provide you with a background and understanding of Fischer-Tropsch history, technology, and the products produced by this process.

Syntroleum Background

Syntroleum was founded by our current Chairman, Mr. Ken Agee in the mid 1980's. Mr. Agee focused on the application of the FT chemistry for conversion of natural gas. Initial efforts were directed at the research and development of a suitable catalyst. By the mid 1990's the company was in a position to expand from the research lab to construction of a pilot plant for further testing of its proprietary cobalt catalyst and begin developing plant design details. By 2002, Syntroleum had advanced its technology to the next development stage, construction and operation of a demonstration scale plant.

In early 2000, Syntroleum in conjunction with Atlantic Richfield Company (ARCO) operated a demonstration plant at ARCO's Cherry Point refinery. In 2002 upon British Petroleum's acquisition of ARCO, Syntroleum, in conjunction the participation of Integrated Concepts Research Corporation (ICRC) and Marathon Oil Company, moved this demonstration plant from Cherry Point, Washington to the Port of Catoosa near Tulsa, Oklahoma. This effort was partially funded by the Department of Energy Ultra Clean Fuels Program under a subcontract with ICRC, allowing for the expansion of the demonstration plant to a fully integrated plant capable of producing a finished transportation fuels. Groundbreaking for the Catoosa Demonstration Facility ("CDF") took place in August 2002 and first finished fuels production for the nominal 70 barrel per day plant occurred in March of 2004.

Syntroleum continues to own and operate its facilities for the development of a commercial scale FT plant. Syntroleum's fully integrated plant has over 18,000 hours of runtime and has produced over 300,000 gallons of FT product. These fuels have been extensively tested by transit fleets, engine testing labs, product testing labs, universities, and specifically the Air Force and Army.

Based on information from the Air Force, Syntroleum is the only company to date that has delivered sufficient quantities of 100% FT product to the U.S. military to perform extensive tests, including turbine emissions testing. Recently, our plant was chosen to produce the initial fuels for the Department of Defense Assured Fuels Initiative. As part of the Assured Fuels Initiative, the Air Force is scheduled to test Syntroleum's product in a B-52 flight test this fall.

The History of Fischer-Tropsch

The Fischer-Tropsch chemistry and process was developed by two German scientists, Franz Fischer and Hans Tropsch in the 1920's, with the first German patent being issued in 1925. The basic reaction chemistry is known as a hydro-polymerization of carbon monoxide. Essentially, this is the combining of carbon monoxide ("CO") and hydrogen ("H_2") to form a long chain hydrocarbon molecule. The initial German efforts were to provide the country, which lacked indigenous oil resources, a means of supporting chemical feedstock requirements and military operations. Germany's first two FT plants, approximately 1,500 barrels per day of capacity, utilized cobalt based FT catalyst and generated the required feedstock (synthesis gas), a mixture of CO and H_2, from coal and coke. History reflect that the initial startup of these plants occurred in the 1935 - 1936 timeframe.

During the World War II years, a total of 13 FT plants were constructed, nine of which were located in Germany. All plants utilized cobalt catalyst in a fixed bed reactor system with coal or coke derived synthesis gas. Germany reached a maximum production of approximately 16,000 barrels per day in 1944; all based on their cobalt catalyst FT process. Significant research and development efforts were initiated on iron based FT catalyst due to the scarcity of cobalt in Germany and the desire to produce a high octane gasoline. The efforts on iron based FT catalyst research were not commercialized by the Germans. Additionally, development of large scale slurry reactors capable of producing more FT product were initiated, but never completed due to war related problems. Copies of the original German documents and their translation are available at the www.fischer-tropsch.org website.

Post World War II, extensive FT catalyst and process patents were issue primarily to US companies. Under the US Synthetic Fuels Act (1944 – 1955) the US Bureau of Mines constructed a nominal 50 barrel per day iron based FT plant located in Louisiana, Missouri. This plant produced approximately 1.5 million gallons of gasoline which was fleet tested by the Armed Services. A second US plant was constructed and operated in the 1947 to 1957 timeframe in Brownsville, Texas. This approximately 8,000 barrel per day plant employed iron based catalyst and utilized natural gas as the feedstock, making it the first "gas-to-liquids" plant in the world. Technical difficulties and the oil price collapse in the mid 1950's rendered the plant uneconomic.

Due to the oil price collapse of the 1950's, synthetic fuel development essentially halted for the next 20 years or so except for development efforts in South Africa and German plants which were moved into Russia or areas controlled by Russia. Three plants were located within the Russian security zone (2 in East Germany and 1 in current day Poland). At least 1 and maybe 2nd German FT plants were relocated to the USSR and in operation during the 1952 – 1954 timeframe. Little is known about these plants, but Russian technical teams were active post WWII.

In 1950, the South African Coal, Oil Gas and Gas Corporation (Sasol) was formed. First FT production by Sasol in 1955 was based on coal derived synthesis gas ("CTL") utilizing iron based catalyst at their Sasolburg facility. The plant was built to operate both low and high temperature reactors initially producing gasoline and later switching to chemicals production. Capacity for the initial plant was approximately 8,000 barrels per day. The government funded efforts continued, culminating in startup of Sasol Two and Three at their Secunda facility in the 1980's. Currently, Sasol produces 150,000 to 160,000 barrels per day of FT product from coal derived synthesis gas with an iron based catalyst. Additional facilities are operated to provide required research and development activities for their natural gas and cobalt catalyst based FT applications.

Since 1990, three large scale FT plants have been constructed all utilizing natural gas as a feedstock. Mossgas, now PetroSA, built as part of a government project, operates a 30,000 barrel per day facility built in 1992 to produce bulk fuel by licensing the Sasol technology. In 1993, Shell completed a nominal 12,000 barrel per day facility utilizing Shell's fixed bed process (Shell "Middle Distillate Synthesis" – MDS). Currently in start-up is the Sasol Oryx plant located in Qatar. This nominal 34,000 barrel per day plant utilizes a cobalt based FT catalyst for the primary purpose of producing diesel fuel and possibly synthetic lubricants with the primary market being Europe.

Industry Status

Sasol clearly has the most experience in FT technology and operations, in part to the early efforts of the South African government program. Public information indicates Sasol is currently working to expand the Oryx (Qatar) project by 66,000 barrels per day and develop an additional fully integrated GTL project in Qatar with their partner, Chevron, of 130,000 barrels per day. Additional work is proceeding on their 34,000 barrel per day GTL plant in Nigeria and a significant expansion (30-40%) of their South African facilities. Additional business development efforts include feasibility studies for two nominal 80,000 barrel per day coal to liquids plants in China and reported interest in Indian projects with India Oil Company. Sasol has recently discussed their potential interest in US based CTL projects in addition to the announced WMPI project in Pennsylvania.

Syntroleum continues to operate their nominal 70 barrel per day facility located near Tulsa, Oklahoma in support of technology enhancement and to provide FT product to the US Department of Defense. Business development efforts are focused on deploying Syntroleum's marine and land based FT technology and the potential development of several domestic CTL projects.

Shell continues operation of their GTL plant in Malaysia providing FT diesel to the Far East and European markets focused on reduction of air emissions. Shell has announced a 70,000 – 140,000 barrel per day GTL plant in Qatar, but the current project status is unknown. To date, Shell has not announced any additional projects.

Statoil-PetroSA continues to operate the 1,000 barrel per day GTL demonstration plant located at Mossel Bay, South Africa. To date, no definitive commercial projects have been announced.

ExxonMobil has announced a 150,000 barrel per day GTL plant to be located in Qatar. The current status of the project is unknown, but it appears this project will not be delayed by the Qatar government upon completion of commercial arrangements. ExxonMobil technology is based on cobalt catalyst and associated operating experience from their 200 barrel per day demonstration plant in Baton Rouge, Louisiana which was operated in the 1990 – 1993 timeframe. ExxonMobil would appear to be the leader in FT patents with over 3,500 patents assigned to it. In 2004, Syntroleum signed a worldwide license with ExxonMobil for access to their Gas to Liquids (GTL) patents to produce and sell fuels from natural gas or other carbonaceous substances such as coal.

ConocoPhillips also utilizes a cobalt based FT process and operated a 400 barrel per day demonstration plant at their Ponca City, Oklahoma facility from 2003 to 2005. Their announced 80,000 to 160,000 barrel per day GTL plant in Qatar has been put on hold by the Qatar government. BP and Institut Francais du Petrole (IFP) / Agip continue the development of their respective technologies with no known announcements of commercial projects. BP continues to operate their FT demonstration plant in Nikiski, Alaska which is not currently capable of producing a finished product. Rentech continues development of their proposed conversion of a natural gas based fertilizer plant in Illinois to a nominal 5,800 barrel per day CTL plant. Additional proposed projects that have been announced are a 10,000 barrel per day CTL plant in Natchez, Mississippi and a license for DKRW's proposed 40,000 barrel per day plant in Wyoming and construction of a 10 barrel per day demonstration plant in Colorado.

Fischer-Tropsch Technology and Products

From a chemistry standpoint, the Fischer-Tropsch reaction is the hydro-polymerization of carbon monoxide. In essence, a synthesis gas stream consisting predominantly of carbon monoxide (CO) and Hydrogen (H_2) is reacted in the presence of a FT catalyst. The CO molecule splits into carbon and oxygen and a hydrogen molecule attaches to each resulting in production of a stream containing hydrocarbon compounds and water. The reaction requires a H_2/CO ratio of in the range of 2.1 – 2.15 for production of transportation fuels and produces approximately 1.1 barrels of water for each barrel of FT product. The hydrocarbons produced by the FT reaction prior to product upgrading, range in carbon number from C_1 (methane) to C_{100+} . The typical carbon number range for a diesel fuel is C_8 thru C_{20}.

The key concept for FT is that the synthesis gas can be produced from almost any carbon containing substance, the most abundant sources being natural gas and coal. Additional carbon sources such as petroleum coke or biomass (wood, farming waste, grasses, sewage) could also be utilized as a feedstock with the appropriate technology for conversion to a synthesis gas. In a CTL application a number of steps are required to convert the solid coal into a CO and H_2 synthesis gas stream. The coal is mined, prepared for gasification, gasified, water-gas shifted to adjust the H_2/CO ratio, and finally cleaned prior to delivery to a FT reactor for conversion to a hydrocarbon product. A component of the synthesis gas clean-up process is to remove the carbon dioxide prior to the FT reactor. Removal and capture of the CO_2 allows for sequestration or enhanced oil recovery opportunities.

Individual companies have developed specific FT catalysts, but iron and cobalt based catalyst are the predominate formulations utilized currently. Each catalyst type has specific attributes, but the current commercial project developments in Qatar all utilize a cobalt based catalyst. Cobalt based FT catalysts have been shown to be more selective towards the production of mid-distillate range hydrocarbon product, which is the range for diesel and aviation finished fuels. Additionally, cobalt catalysts are more active, and as a result produce more barrels of FT product per lb of FT catalyst, which equates to smaller FT reactors for equivalent FT production. Iron based FT catalyst is more suited to the production of chemical feedstock due to their inherent selectivity towards producing olefins and aromatics at high temperature operation.

The primary issue with using a cobalt based FT catalyst in a CTL plant is the ability to clean the synthesis gas to acceptable impurity levels. It is believed that through the use of Lurgi's Rectisol process and subsequent synthesis gas clean-up processes, such as charcoal beds, levels required for economic use of a cobalt catalyst can be achieved. For example, Eastman Chemical Company has been producing methanol from a coal derived synthesis gas for approximately 20 years. Although the catalyst is different, the methanol stream Eastman produces is utilized for a variety of end products and healthcare feedstock where high quality synthesis gas is a requirement.

Upon final clean-up, the synthesis gas enters the FT reactor for conversion to a raw hydrocarbon product. For a commercial scale GTL facility, 17,000 to 20,000 barrel per day, a single FT reactor is approximately 34 feet in diameter and 180 feet tall. These vessels can weigh in the range of 2,000 tons each. As a reference point, the new MIA2 tank weighs about 68 tons, so a single GTL FT reactor can approximate the weight of 30 MIA2 tanks. The FT reaction is a vigorous reaction which produces significant heat which must be removed. In addition to the basic reactor shell, the FT reactor internals are essentially a piping system to evenly distribute the synthesis gas within the reactor and a set of heat transfer tubes to remove excess heat. Due to the size and complexity of these reactors, only a limited number of companies can construct FT reactors. For CTL projects, due to the potential transportation, logistical, and safety issues associated with moving a vessel of this size, on-site construction may be required.

The raw hydrocarbon product is further processed / upgraded to enhance the properties of the finished fuels, chemical feedstock, or waxes. For the transportation market, typical FT finished diesel contains non-detectable levels of sulfur, aromatics and has a cetane index of 74+. Syntroleum has been working with and supplied the Air Force, Army, and Navy FT product. Based on our understanding from discussions with the Air Force, Syntroleum's FT product is the only fuel that has been extensively tested to date with respect to emissions reduction. The Air Force results, dependent upon equipment and operating conditions, have shown in excess of 90% reduction in particulate matter emissions. Testing performed by the Army – National Automotive Center, has shown particulate matter and hydrocarbon emission reductions of 50+% and 60+% respectively compared with low sulfur diesel fuel.

The testing performed on Syntroleum's FT fuels by the Air Force, Army, and Navy has shown that FT fuels also provide a number of other performance benefits, such as increased thermal stability and cold performance properties. Currently, FT fuels are not fully certified for use in aircraft. Our understanding based on meetings with the Department of Defense, is that a component of the Assured Fuels Initiative is to certify the use of FT fuels for turbine applications which would eventually crossover to the commercial sector.

In conclusion, the technology to convert the nation's vast coal resources to ultra-clean fuels via the Fischer-Tropsch process exists today. The capital cost associated with a CTL plant have been estimated in the $80,000 to $100,000 per barrel range with 70% to 75% associated with the gasification and clean-up process required to produce a synthesis gas. As an example, a 20,000 barrel per day plant is estimated to cost between $1.6 and $2.0 billion. Based upon 2003 Energy Information Agency data, the US has a demonstrated coal reserve base of 496 billion tons. At a conservative conversion rate of 1.5 barrels of FT product for each ton of coal the potential for domestically produced CTL is 744 Billion barrels of product, essentially equal to the crude oil reserves of the Middle East.

Finally, thank you for the opportunity to address the Subcommittee on this important issue as industry and government work towards making CTL a reality in the United States.